IN THE UNITED STATE PATENT AND TRADEMARK OFFICE

In re application of :
Akihisa HONGO al. : Docket No. 2001-0133A
Serial No. 09/762,582 : Group Art Unit 1753
Filed April 12, 2001 : Examiner Arun S. Phasge
SUBSTRATE PLATING
METHOD AND APPARATUS

VERIFYING DECLARATION

Commissioner for Patents
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Alexandria, VA 22313-1450

Sir:

I, Tomohiro Mori, declare and say:

that I am thoroughly conversant in both the Japanese and English languages;

that I am presently engaged as a translator in these languages;

that the attached document represents a true English translation of Japanese Patent Application No. H11-030230 filed on February 8, 1999.

I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that there statements were made with the knowledge that willful false statements and like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Signed this 4th day of November, 2005

Tomohiro Mori
TRANSLATOR

Filing date: February 8, 1999
No. 11-030230

(THE NAME OF DOCUMENT) PATENT APPLICATION

(REFERENCE NUMBER) EB10-661

(DESTINATION) DIRECTOR GENERAL OF THE PATENT OFFICE

(INTERNATIONAL PATENT CLASSIFICATION) H01L 21/02

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(THE NAME OF DOCUMENT)	SPECIFICATION	1
(THE NAME OF DOCUMENT)	DRAWINGS	1
(THE NAME OF DOCUMENT)	ABSTRACT	1

(THE NUMBER OF GENERAL POWER OF ATTORNEY) 9005856

(PROOF) Yes

(NAME OF DOCUMENT) SPECIFICATION

(TITLE OF THE INVENTION) ELECTROLESS PLATING APPARATUS

(CLAIMS)

(CLAIM 1) An electroless plating apparatus for forming a metal plating film on a plating surface of a substrate to be plated by bringing an electroless plating liquid into contact with the plating surface, said electroless plating apparatus characterized by comprising:

hermetically sealed space forming means for facing the plating surface of the substrate upward and forming a hermetically sealed space so as to face the plating surface; and plating liquid supply means for supplying an electroless plating liquid to the hermetically sealed space, wherein an electroless plating liquid is supplied to the hermetically sealed space to conduct electroless plating.

(CLAIM 2) An electroless plating apparatus according to claim 1, characterized in that:

the minimum amount of electroless plating liquid required for performing a predetermined plating on the substrate to be plated is supplied to the hermetically sealed space, and the electroless plating process is performed with the electroless plating liquid in a static state.

(CLAIM 3) An electroless plating apparatus according to claim 1 or 2, characterized by comprising:

pressure pulsation means for generating a pressure in said hermetically sealed space that is higher than atmospheric pressure and for pulsating said pressure.

(CLAIM 4) An electroless plating apparatus according to any one of claims 1 through 3, characterized by comprising:

a preparation bath disposed in the vicinity of the hermetically sealed space for supplying the minimum amount of prepared electroless plating liquid to the hermetically sealed space just prior to the electroless plating process.

(CLAIM 5) An electroless plating apparatus according to any one of claims 1 through

4, characterized in that:

the electroless plating liquid is processed as a waste liquid without circulating the electroless plating liquid after performing the electroless plating process with the minimum amount of electroless plating liquid.

(DETAILED DESCRIPTION OF THE INVENTION)

(0001)

(FIELD OF THE INVENTION)

The present invention relates to an electroless plating apparatus for electroless plating a substrate such as a semiconductor wafer to be plated with metal such as copper.

(0002)

(PRIOR ART)

Recently, electroless copper plating has been employed to form interconnection layers on a substrate such as a semiconductor wafer. In the electroless copper plating, hydrogen gas is generated so as to cause adverse influence on the plating. For example, when formalin (HCHO) is used in the electroless plating process as a reducing agent, hydrogen gas (H_2) is generated according to the following reaction.

$$Cu^{2+} + 2HCHO + 4OH^- \rightarrow Cu^{2+} + 2HCHOO^- + H_2 + 2H_2O + 2e^-$$

$$\rightarrow Cu + 2HCOO^- + H_2 + 2H_2O$$

(0003)

When a plating surface 101a of a substrate 101 faces downwardly or sideways, as shown in FIGS. 1(a) and 1(b), bubbles 103 are generated by hydrogen gas (H_2) in a plating liquid Q within recesses 102, such as fine grooves or the like, formed in the substrate 101, and these bubbles 103 cause a plating defect 104.

(0004)

As described above, hydrogen gas is inevitably generated according to properties of the electroless plating. In the conventional electroless copper plating, a

pump or air is used to agitate the plating liquid. Thus, hydrogen gas bubbles 03 generated on the plating surface move on the plating surface by the agitation. As shown in FIG. 2, unevenly plated portions 105 are generated on a plating surface 101a of the substrate 101 in the direction in which the hydrogen gas bubbles 103 move (indicated by the arrow 106) because plating is not conducted at portions at which the hydrogen gas bubbles 103 remain.

(0005)

In order to remove the hydrogen gas bubbles 103 from the plating surface 101a, the conventional methods employ a jig to grip or suspend the plating substrate, while a shock is applied externally to the jig to separate the bubbles from the plating surface 101a. However, since there is risk that the shock will damage the jig or the plating substrate 101, this method is not desirable.

(0006)

A conventional electroless copper plating apparatus comprises a plating processing tank and a plating liquid circulating tank, and a plating liquid is circulated during the plating process. The plating liquid is prepared in a special preparation bath or in the circulating tank. Therefore, problematic reactions specific to the electroless copper plating (a Cannizzaro reaction or a disproportionation) occur in the electroless plating liquid immediately after preparation to cause deterioration of the plating liquid and changes in concentration of the plating liquid composition.

(0007)

Further, as shown in FIG. 3, a conventional electroless copper plating apparatus has a pre-treatment tank 111, a rinse tank 112, a plating tank 113, a rinse tank 114, and a dry tank 115. A substrate 101 to be plated is griped or suspended by a jig 120 and immersed in the respective tanks to perform a plating process. Accordingly, the apparatus has a large installation space. Particularly, when the apparatus is installed in a clean room of semiconductor fabrication facilities, loads on a floor or an installation space becomes problematic. In FIG. 3, the reference numeral 117 denotes a pump to circulate a

pre-treatment liquid to the pre-treatment tank 111, the reference numeral 118 a pump to circulate a plating liquid to the plating tank 113, and the reference numeral 119 a fan to supply dry air to the dry tank 115.

(0008)

(PROBLEM TO BE SOLVED BY THE INVENTION)

The present invention has been made in view of the above drawbacks. It is, therefore, an object of the present invention to provide an electroless plating apparatus which can minimize the amount of plating defects and unevenly plated portions and can prevent deterioration of a plating liquid and changes in concentration of the plating liquid composition to perform a plating process with a highly stable quality.

(0009)

It is another object of the present invention to provide an electroless plating apparatus which can avoid increases in cost with a waste liquid and an excessive burden on environment even if a plating liquid that has been used to perform a plating process with a highly stable quality is processed as waste liquid, is compact and lightweight, suitable to be installed in a clean room, and can maintain a plating temperature at a constant value.

(0010)

(MEANS FOR SOLVING THE PROBLEM)

In order to resolve the above drawbacks, according to the present invention as defined in claim 1, there is provided an electroless plating apparatus for forming a metal plating film on a plating surface of a substrate to be plated by bringing an electroless plating liquid into contact with the plating surface, said electroless plating apparatus characterized by comprising: hermetically sealed space forming means for facing the plating surface of the substrate upward and forming a hermetically sealed space so as to face the plating surface; and plating liquid supply means for supplying an electroless plating liquid to the hermetically sealed space, wherein an electroless plating liquid is supplied to the hermetically sealed space to conduct electroless plating.

(0011)

As described above, by facing the plating surface of the substrate to be plated upwardly, nitrogen gas bubbles certainly generated in the plating liquid in the electroless plating process will moved upwardly due to buoyancy. Accordingly, the number and the amount of bubbles remaining on the plating surface of the plating substrate and in the fine groove and hole can be reduced, for thereby reducing the plating defects.

(0012)

According to the present invention as defined in claim 2, there is provided an electroless plating apparatus according to claim 1, characterized in that: the minimum amount of electroless plating liquid required for performing a predetermined plating on the substrate to be plated is supplied to the hermetically sealed space, and the electroless plating process is performed with the electroless plating liquid in a static state.

(0013)

As described above, the minimum amount of electroless plating liquid required for performing a predetermined plating on the substrate to be plated is supplied to the hermetically sealed space, and the electroless plating process is performed with the electroless plating liquid in a static state. Since this method does not move the nitrogen gas bubbles over the plating surface, it is possible to minimize the unevenly plated portions that are generated on the plating surface as shown in FIG. 2.

(0014)

According to the present invention as defined in claim 3, there is provided an electroless plating apparatus according to claim 1 or 2, characterized by comprising: pressure pulsation means for generating a pressure in said hermetically sealed space that is higher than atmospheric pressure and for pulsating said pressure.

(0015)

As described above, since the hydrogen gas bubbles can be encouraged to dissolve into the electroless plating liquid by pressurization, it is possible to encourage the nitrogen gas bubbles to separate from the plating surface. Specifically, the nitrogen gas

bubbles 103 attached to the plating surface 101a of the plating substrate 101, as shown in FIG. 4(a), are contracted by pressurization, as shown in FIG. 4(b), to separate from the plating surface 101a. The nitrogen gas bubbles 103 are expanded by decompression, as shown in FIG. 4(c), to separate completely from the plating surface 101a.

(0016)

According to the present invention as defined in claim 4, there is provided an electroless plating apparatus according to any one of claims 1 through 3, characterized by comprising: a preparation bath disposed in the vicinity of the hermetically sealed space for supplying the minimum amount of prepared electroless plating liquid to the hermetically sealed space just prior to the electroless plating process.

(0017)

As described above, the minimum required amount of plating liquid prepared in the preparation bath disposed in the vicinity of a hermetically sealed space (plating process section) is supplied to the hermetically sealed space just before the plating. Therefore, the plating process is completed before occurrence of problematic reactions specific to the electroless copper plating (a Cannizzaro reaction or a disproportionation) which cause deterioration of the plating liquid and changes in concentration of the plating liquid composition immediately after the preparation. Accordingly, the plating process can be performed with a highly stable quality.

(0018)

According to the present invention as defined in claim 5, there is provided an electroless plating apparatus according to any one of claims 1 through 4, characterized in that: the electroless plating liquid is processed as a waste liquid without circulating the electroless plating liquid after performing the electroless plating process with the minimum amount of electroless plating liquid.

(0019)

As described above, an electroless plating liquid that has been used for plating is processed as waste liquid without circulation or reuse. Therefore, it is possible

to perform a plating process with a highly stable quality. Further, since the amount of plating liquid used per deposition (deposition of plating layer) can be maintained to be the minimum required amount, it is possible to avoid increases in cost with the waste liquid and an excessive burden on the environment.

(0020)

In the electroless plating apparatus as defined in any one of claims 1 through 5, the plating substrate may be held on a turntable to be rinsed and dried after the plating process.

(0021)

As described above, since the plating substrate is held on a turntable to be rinsed and dried after the plating process, the plating, rinsing, and drying processes can all be performed in the same area. Therefore, the installation space for the apparatus can be reduced, and the apparatus can be made suitable to be installed in a clean room.

(0022)

In the electroless plating apparatus as defined in any one of claims 1 through 5, a hot bath for maintaining temperature may be provided in the electroless plating tank in the vicinity of the top of the hermetically sealed space, and a heater for maintaining temperature may be disposed below the plating substrate.

(0023)

As described above, since a hot bath for maintaining temperature is provided above the hermetically sealed space while a heater for maintaining temperature is provided below the plating substrate, it is possible to maintain a fixed plating temperature, which is one of the most important factors governing the quality (uniformity of layer thickness, reproducibility, electric conductivity of the plating layer, etc.) of electroless plating.

(0024)

In the electroless plating apparatus as defined in any one of claims 2 through 5, the minimum required amount of electroless plating liquid may be set within a

range of amount of liquid that includes ions of solutes 1.5 to 20 times as many as a predetermined deposited metal equivalent.

(0025)

In the electroless plating apparatus as defined in any one of claims 3 through 5, the pressure pulsation means may be configured to generate pressure pulsations having an amplitude of 0 to 1 MPa and a frequency of 0 to 10 Hz.

(0026)

(EMBODIMENT)

An embodiment of the present invention will be described below with reference to the accompanying drawings. FIG. 5 is a schematic view showing a configurational example of the electroless plating unit. In FIG. 5, the reference numeral 2 denotes a turntable for holding a substrate 1 to be plated such as a semiconductor substrate thereon. A heater 3 for maintaining temperature is provided in the turntable 2, and the turntable 2 can vertically be moved via a ball screw 15 by a motor 16 and rotated via a timing belt 13 by a motor 14.

(0027)

A plating cell 22 having an opening in its lower surface is disposed above the turntable 2, and a seal packing 21 which is brought into close contact with the plating substrate 1 held by a housing 26 is provided at the outer edge of the lower end of the plating cell 22. Specifically, when the turntable 2 is upwardly moved, a hermetically sealed space is formed in the plating cell 22 in such a state that the surface of the plating substrate 1 is brought into close contact with the seal packing 21. The hermetically sealed space has a volume sufficient for accommodating the minimum amount of plating liquid (electroless plating liquid) required for performing a predetermined plating on the surface of the plating substrate 1, as described later.

(0028)

A preparation bath 4 is disposed in the vicinity of the upper portion of the plating cell 22 and supplied with plating liquids A, B, C, and pure water D. An impeller

6a connected to an agitator 6 is disposed in the preparation bath 4, and a heater 11 is disposed in the preparation bath 4. A plating liquid in the preparation bath 4 is supplied to the plating cell 22 via a plating liquid supply valve 9.

(0029)

A hot bath 5 is disposed in the vicinity of the outer portion of the preparation bath 4 so as to surround the preparation bath 4. An impeller 7a connected to an agitator 7 is disposed in the hot bath 5, and a heater 12 is disposed in the hot bath 5. The reference numeral 10 denotes a plating liquid discharge valve for discharging a plating liquid after the plating process is completed in the plating cell 22. A plating liquid discharged through the plating liquid discharge valve 10 flows into a waste liquid tank 23. The reference numeral 8 denotes a pressure supply valve for supplying pressure into the plating cell 22. The pressure in the plating cell 22 can be pulsed via the pressure supply valve 8 by a pressure pulsation generator 24.

(0030)

The pressure pulsation generator 24 comprises a pressure regulator valve 17 for high pressure, a pressure regulator valve 18 for low pressure, a switching valve 19 for switching pressure, and a pneumatic pressure source 20, and can generate pressure pulsations having an amplitude of 0 to 1 MPa and a frequency of 0 to 10 Hz. The reference numerals P1, P2 denote pressure gauges.

(0031)

In the electroless plating apparatus thus constructed, when a substrate is plated, the plating substrate 1 is held in a predetermined position on the upper surface of the turntable 2 positioned below the plating cell 22. In this state, the turntable 2 is moved upwardly via the ball screw 15 by the motor 16 to thus bring the upper surface of the plating substrate 1 into close contact with the seal packing 21, for thereby closing the lower opening of the plating cell 22 to form a hermetically sealed space therein. At this time, the supply valve 9 is opened to supply the plating liquid Q in the preparation bath 4 to the plating cell 22.

(0032)

The interior of the plating cell 22 has a volume sufficient for accommodating the minimum amount of plating liquid Q required for performing a predetermined plating on the surface of the plating substrate 1, and this minimum required amount of plating liquid Q is accommodated in the interior of the plating cell 22. Here, the minimum required amount of electroless plating liquid is set within a range of amount of liquid that includes ions of solutes 1.5 to 20 times as many as a predetermined deposited metal equivalent. In the plating process, the pressure pulsation generator 24 applies a pressure pulsation to the plating cell 22 via the pressure supply valve 8 at a predetermined amplitude and a predetermined frequency.

(0033)

Since the plating substrate 1 is held on the upper surface of the turntable 2 in such a state that the surface to be plated faces upwardly, hydrogen gas bubbles certainly generated in the plating liquid Q in the electroless plating process is moved upwardly due to buoyancy. Therefore, the number and the amount of bubbles remaining on the plating surface of the plating substrate 1 and in fine grooves and holes are reduced, for thereby reducing the plating defects. Further, the minimum required amount of plating liquid Q is supplied to the hermetically sealed space in the plating cell 22, and the substrate is plated in a stationary state. Hence, the hydrogen gas bubbles are not moved on the plating surface, for thereby minimizing the amount of unevenly plated portions generated on the plating surface.

(0034)

The pressure of the hermetically sealed space in the plating cell 22 is set to be higher than atmospheric pressure and pulsed by the pressure pulsation generator 24. Hence, as described above, the hydrogen gas bubbles 98 can be encouraged to dissolve into the electroless plating liquid Q by pressurization and simultaneously encouraged to separate from the plating surface by pressure pulsation (see FIGS. 4(a) through 4(c)).

(0035)

The preparation bath 4 is disposed in the vicinity of the upper portion of the plating cell 22, and the minimum required amount of plating liquid prepared in the preparation bath 4 is supplied to the plating cell 22 just before the substrate 1 is plated. Hence, the plating process is completed before occurrence of problematic reactions specific to the electroless copper plating (a Cannizzaro reaction or a disproportionation) which cause deterioration of the plating liquid and changes in concentration of the plating liquid composition after the preparation. Therefore, the plating process can be performed with a highly stable quality.

(0036)

The plating liquid Q used for plating is discharged from the plating cell 22 via the plating discharge valve 10 into the waste liquid tank 23, where the plating liquid Q is processed as a waste liquid. Hence, the plating process can be performed with a highly stable quality. In addition, since the amount of plating liquid used per deposition is maintained to be the minimum required amount, it is possible to avoid increases in cost with the waste liquid and an excessive burden on the environment. Further, since the hot bath 5 is disposed above the plating cell 22 and the heater 3 for maintaining temperature is disposed below the turntable 2, it is possible to maintain a fixed plating temperature, which is one of the most important factors governing the quality (uniformity of layer thickness, reproducibility, electric conductivity of the plating layer, etc.) of electroless plating.

(0037)

After the plating process is completed, as described above, the plating liquid discharge valve 10 is opened to discharge the plating liquid in the plating cell 22 to the waste liquid tank 23. The turntable 2 is moved downwardly via the ball screw 15 by the motor 16, and a cleaning liquid (mainly pure water) is ejected from a cleaning nozzle 25 shown in FIG. 6 to the plating surface of the plated substrate 1 to clean the plating surface. In this cleaning process, the cleaning nozzle 25 is swung, and the plating substrate 1 is slowly rotated via the timing belt 13 by the motor 14.

(0038)

After the cleaning process is completed, the plating substrate 1 is rotated at a high speed to spin off the cleaning liquid attached to the plating substrate 1 by centrifugal force.

(0039)

In the above embodiment, the electroless plating apparatus performs a plating process and a drying process. The pre-treatment tank may be provided in the vicinity of the plating cell. A pre-treatment liquid may be supplied to the plating cell 22 from the pre-treatment tank prior to a plating process. After the pre-treatment process, cleaning may be conducted. Then, a plating process, a cleaning process, and a drying process may be performed. In such a case, a pre-treatment process, a cleaning process, a plating process, a cleaning process, and a drying process can be performed in a single electroless plating apparatus. Thus, it is possible to provide a compact apparatus which can perform all of these processes in a single unit and requires a small installation space.

(0040)

In the above embodiment, electroless copper plating is conduced. However, an electroless plating apparatus according to the present invention is not limited to this example, and the present invention is applicable to electroless plating with other metals.

(0041)

(EFFECT OF THE INVENTION)

As described above, according to the present invention as defined in claims, it is possible to obtain the following advantageous effects.

(0042)

According to the present invention as defined in claim 1, by facing the plating surface of the substrate to be plated upwardly, nitrogen gas bubbles certainly generated in the plating liquid in the electroless plating process will moved upwardly due to buoyancy. Accordingly, the number and the amount of bubbles remaining on the plating surface of the plating substrate and in the fine groove and hole can be reduced, for

thereby reducing the plating defects.

(0043)

According to the present invention as defined in claim 2, the minimum amount of electroless plating liquid required for performing a predetermined plating on the substrate to be plated is supplied to the hermetically sealed space, and the electroless plating process is performed with the electroless plating liquid in a static state. Since this method does not move the nitrogen gas bubbles over the plating surface, it is possible to minimize the unevenly plated portions that are generated on the plating surface.

(0044)

According to the present invention as defined in claim 3, since the hydrogen gas bubbles can be encouraged to dissolve into the electroless plating liquid by pressurization, it is possible to encourage the nitrogen gas bubbles to separate from the plating surface.

(0045)

According to the present invention as defined in claim 4, the minimum required amount of plating liquid prepared in the preparation bath disposed in the vicinity of a hermetically sealed space (plating process section) is supplied to the hermetically sealed space just before the plating. Therefore, the plating process is completed before occurrence of problematic reactions specific to the electroless copper plating (a Cannizzaro reaction or a disproportionation) which cause deterioration of the plating liquid and changes in concentration of the plating liquid composition immediately after the preparation. Accordingly, the plating process can be performed with a highly stable quality.

(0046)

According to the present invention as defined in claim 5, an electroless plating liquid that has been used for plating is processed as waste liquid without circulation or reuse. Therefore, it is possible to perform a plating process with a highly stable quality. Further, since the amount of plating liquid used per deposition (deposition of

plating layer) can be maintained to be the minimum required amount, it is possible to avoid increases in cost with the waste liquid and an excessive burden on the environment.

(BRIEF DESCRIPTION OF DRAWINGS)

(FIG. 1)

FIGS. 1(a) and 1(b) are schematic diagrams explanatory of the behavior of hydrogen gas bubbles in electroless plating, FIG. 1(a) shows the behavior of the hydrogen gas bubbles when a plating surface of a plating substrate faces downwardly, and FIG. 1(b) shows the behavior of the hydrogen gas bubbles when the plating surface of the plating substrate faces sideways.

(FIG. 2)

FIG. 2 is a schematic diagram explanatory of unevenly plated portions generated on a plating surface of a plating substrate by the behavior of hydrogen gas bubbles in electrolytic plating.

(FIG. 3)

FIG. 3 is a schematic diagram showing a conventional apparatus for performing a pre-treatment process, a cleaning process, a rinsing process, and a drying process.

(FIG. 4)

FIGS. 4(a) through 4(c) are schematic diagrams explanatory of the behavior of hydrogen gas bubbles when pressure of a hermetically sealed space in the electroless plating device is pulsed.

(FIG. 5)

FIG. 5 is a schematic view showing a structure of an electroless plating apparatus according to the present invention.

(FIG. 6)

FIG. 6 is a schematic view showing a structure of the electroless plating apparatus according to the present invention.

(EXPLANATION OF THE REFERENCE NUMERALS)

1	plating substrate
2	turntable
3	heater
4	preparation bath
5	hot bath
6	agitator
7	agitator
8	pressure supply valve
9	plating liquid supply valve
10	plating liquid discharge valve
11	heater
12	heater
13	timing belt
14	motor
15	ball screw
16	motor
17	pressure regulator valve
18	pressure regulator valve
19	switching valve
20	pneumatic pressure source
21	seal packing
22	plating cell
23	waste liquid tank
24	pressure pulsation generator
25	cleaning nozzle
26	housing

(NAME OF DOCUMENT) ABSTRACT

(ABSTRACT)

(OBJECT) The present invention provides an electroless plating apparatus which can minimize the amount of plating defects and unevenly plated portions and can prevent deterioration of a plating liquid and changes in concentration of the plating liquid composition to perform a plating process with a highly stable quality. It is possible to avoid increases in cost with the waste liquid and an excessive burden on the environment.

(MEANS FOR SOLUTION) An electroless plating apparatus is used to form a metal plating film on a plating surface of a substrate to be plated by bringing an electroless plating liquid into contact with the plating surface. In the electroless plating apparatus, the plating surface of the substrate 1 is faced upward, and a hermetically sealed space 22 is formed in a plating cell 22 so as to face the plating surface. An electroless plating liquid is supplied to the hermetically sealed space via a plating liquid supply valve 9 from a preparation tank 4, and the pressure in the hermetically sealed space is pulsed by a pressure pulsation generator 24.

(SELECTED FIGURE) FIG. 5

REFERENCE NUMBER=EB10-661
(NAME OF DOCUMENT) DRAWINGS
(FIG. 1)

Date of filing February 8, 1999
1999-030230

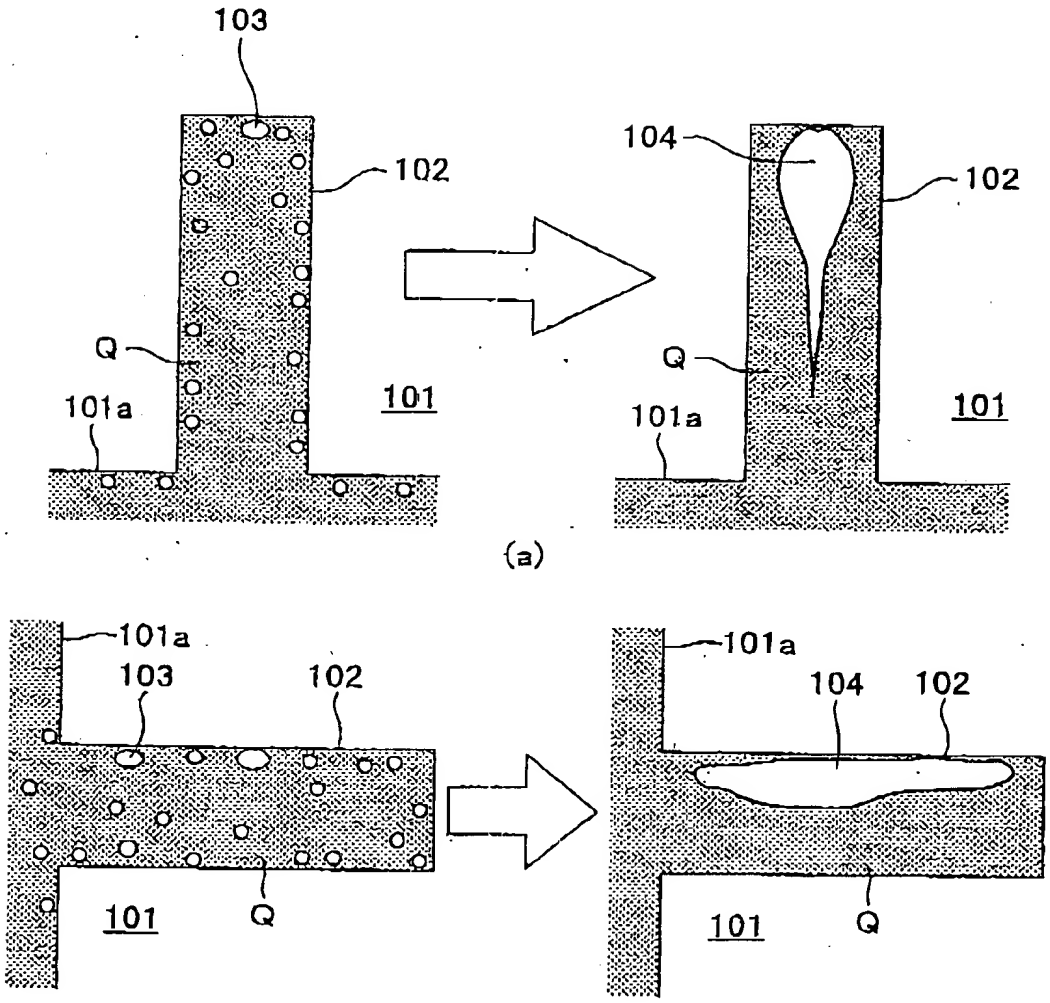
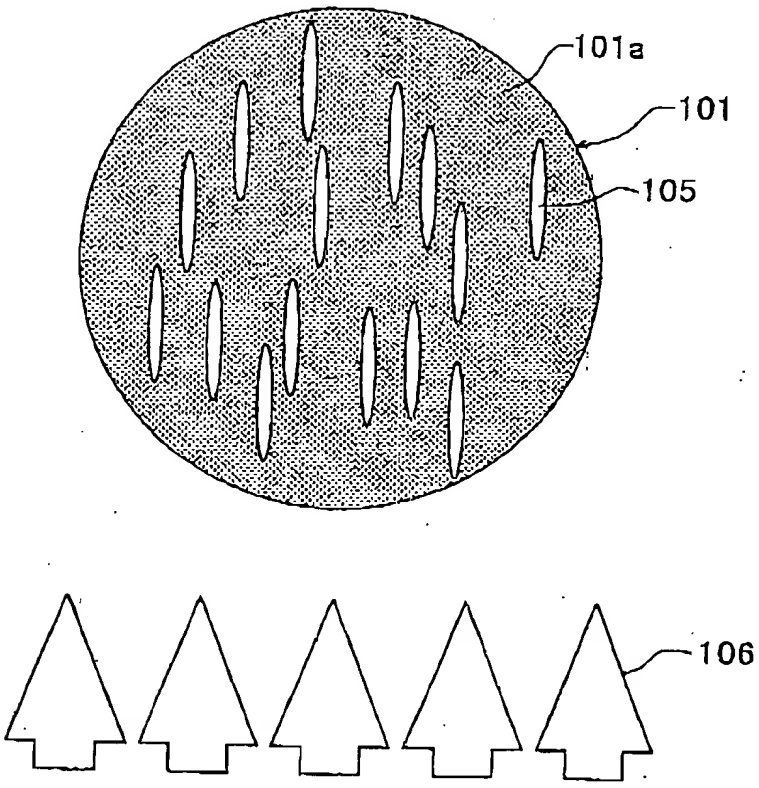


FIG 1

101: Substrate to be plated
101a: Plating surface
102: Fine groove or recess
103: Hydrogen gas bubble
104: Plating defect
Q: Plating liquid

Behavior of hydrogen gas bubbles in electroless plating

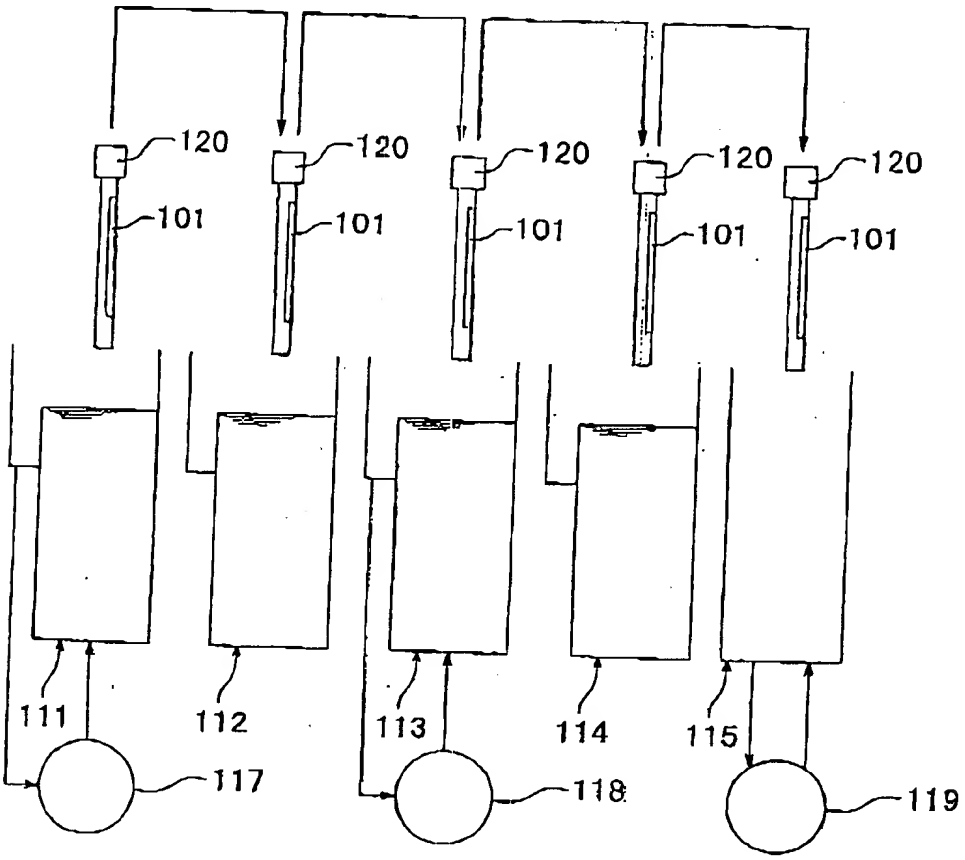


101: Substrate to be plated
101a: Plating surface
105: Unevenly plated portion

Unevenly plated portions generated on plating surface by behavior of hydrogen gas bubbles

REFERENCE NUMBER=EB10-661
(FIG. 3)

Date of filing 1999-030230 February 8, 1999

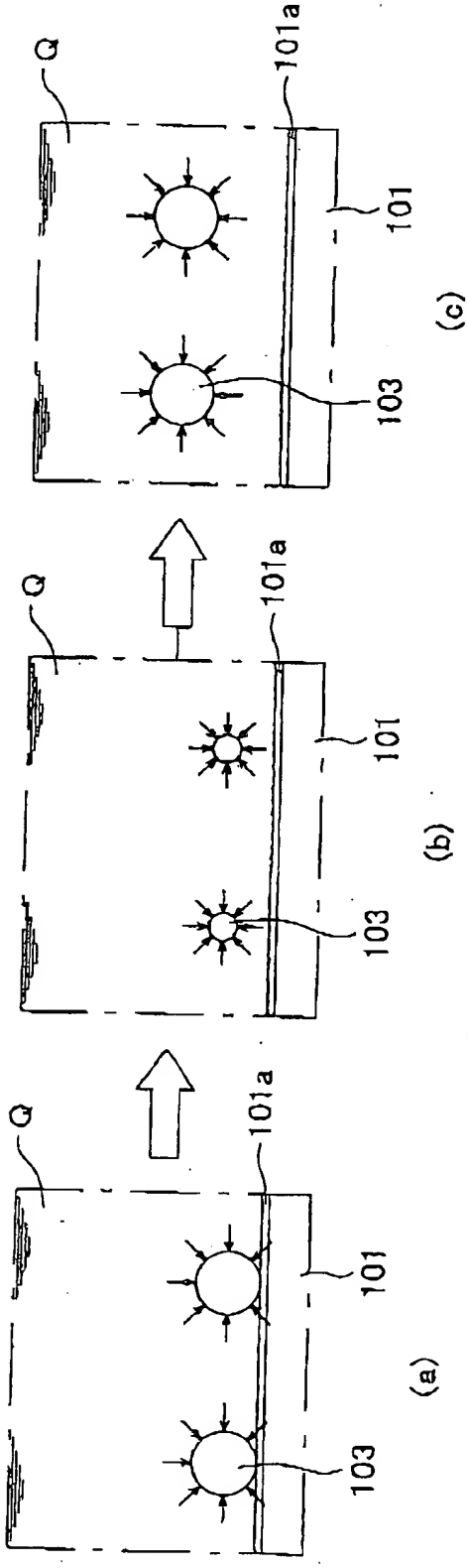


101: Substrate to be plated
111: Pre-treatment tank
112: Rinse tank
113: Plating tank
114: Rinse tank
115: Dry tank
117: Pump
118: Pump
119: Fan
120: Jig

Conventional apparatus for perform a pre-treatment process, a cleaning process, a rinsing process, and a drying process

REFERENCE NUMBER=EB10-661
(FIG. 4)

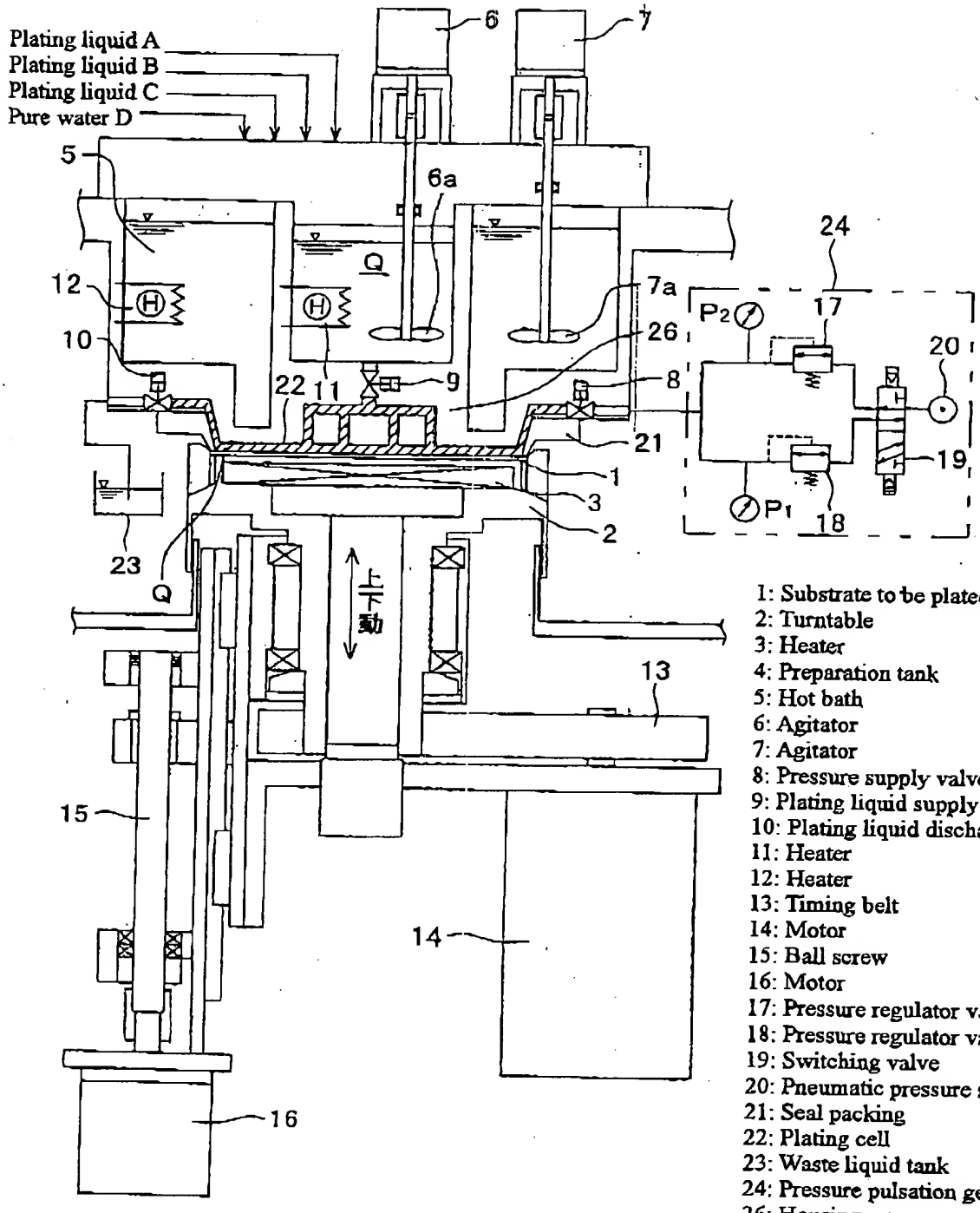
Date of filing February 8, 1999
1999-030230
4/6



101: Substrate to be plated
101a: Plating surface
103: Hydrogen gas bubble
Q: Plating liquid

Behavior of hydrogen gas bubbles when pressure of hermetically sealed space holding electroless plating liquid therein is pulsed.

Date of filing February 8, 1999
REFERENCE NUMBER=EB10-661 1999-030230 5/6
(FIG. 5)



1: Substrate to be plated
2: Turntable
3: Heater
4: Preparation tank
5: Hot bath
6: Agitator
7: Agitator
8: Pressure supply valve
9: Plating liquid supply valve
10: Plating liquid discharge valve
11: Heater
12: Heater
13: Timing belt
14: Motor
15: Ball screw
16: Motor
17: Pressure regulator valve
18: Pressure regulator valve
19: Switching valve
20: Pneumatic pressure source
21: Seal packing
22: Plating cell
23: Waste liquid tank
24: Pressure pulsation generator
26: Housing

Structure of electroless plating apparatus according to present invention

REFERENCE NUMBER=EB10-661
(FIG. 6)

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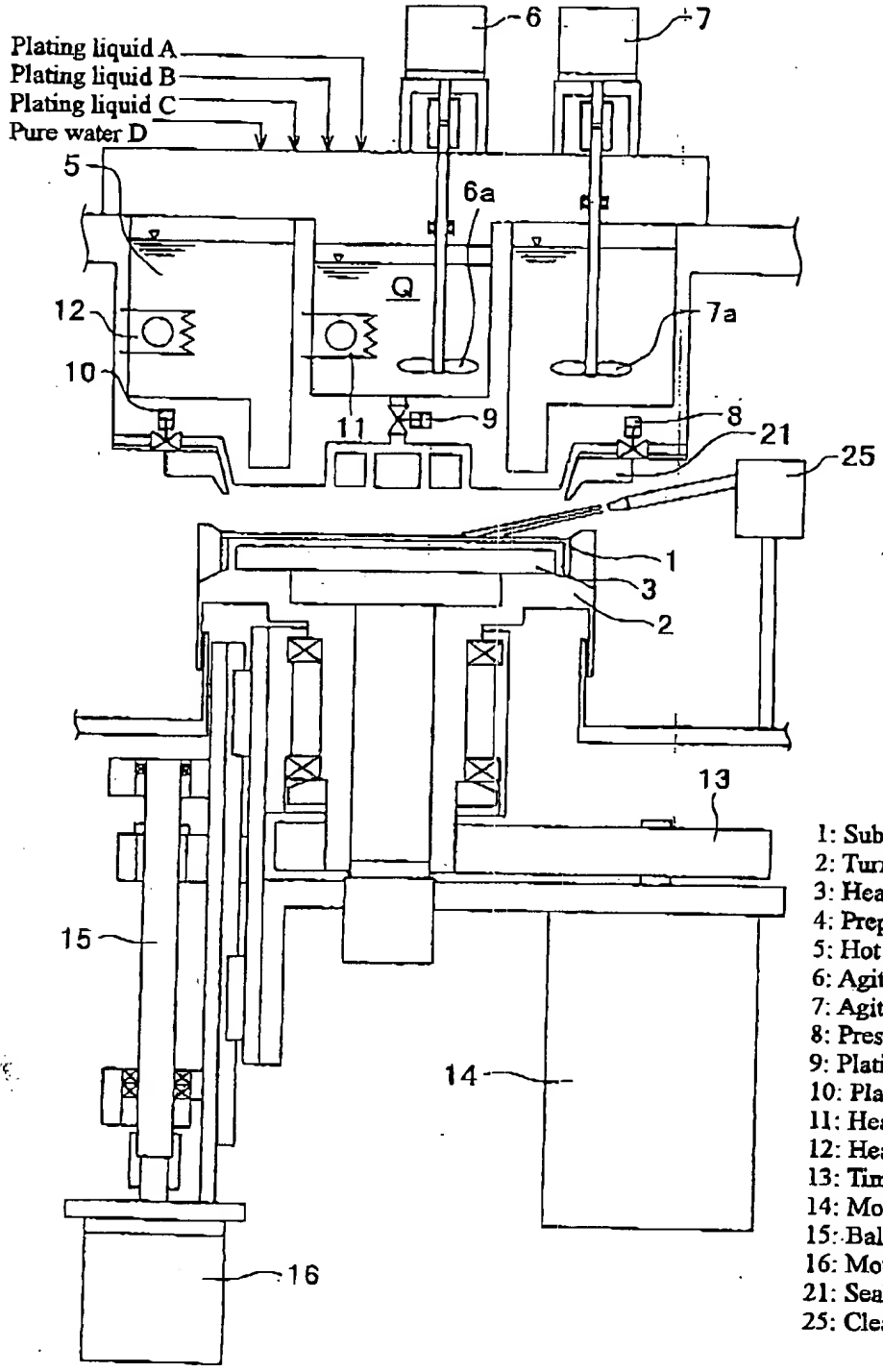

1: Substrate to be plated
2: Turntable
3: Heater
4: Preparation tank
5: Hot bath
6: Agitator
7: Agitator
8: Pressure supply valve
9: Plating liquid supply valve
10: Plating liquid discharge valve
11: Heater
12: Heater
13: Timing belt
14: Motor
15: Ball screw
16: Motor
21: Seal packing
25: Cleaning nozzle

Structure of electroless plating apparatus according to present invention